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Impact of Different Weed Management Practices on Weed Dynamics and Growth Parameters of Doob Grass (*Cynodon dactylon*) in an Establishing Lawn

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A B S T R A C T

A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2017-18 to study the weed management practices in a lawn of doob grass (*Cynodon dactylon*). The experiment was laid out in Randomized Block Design (RBD) with three replications. There were seven treatments *viz.* T_1 (Control), T_2 (Hand weeding at 15 days interval up to 90 days), T_3 (Hand weeding at 30 days interval up to 90 days), T_4 (Pendimethalin @ 1 kg a.i./ha), T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45days, 60 days, 75 days after planting), T_6 (Sulfosulfuron @ 25 g/ha) and T_7 (Sulfosulfuron @ 25 g/ha followed by hand weeding at 45 days, 60 days, 75 days after planting). The weed control practices had significant effects on weed density, weed dry weight, growth characters as well as quality characters of a lawn. Pre-emergence application of pendimethalin @ 1kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 days after planting recorded the lowest weed density and weed dry weight, while they were highest in case of T_1 (Control). The growth of grass was satisfactory with the application of T_5, so nutrient uptake from the soil was more. From the study, it could be inferred that application of T_5 could minimize the weeds and thus it is suitable for establishment of a lawn.

Introduction

Doob grass [*Cynodon dactylon* (L.) Pers] is a creeping perennial grass found mostly in warm climates. This grass is one of the most widely used turf grasses in tropical and sub-tropical regions. Doob grass establishes rapidly and spread by vegetative propagules, both above ground (stolons) and below ground (rhizomes). Roots produced at the distal end of the stolon are much longer and more abundant than those close to the original stem (Rochecouste, 1962). *Cynodon* spp. is one of the most commonly grown turfgrass genera in the southern United States having excellent drought tolerance (Jeffrey *et al.*, 2015). It is a warm-season turf grass and is widely used on home lawns, golf courses and sports fields.

Lawn is considered to be an integral part of a garden. It is an area of soil-covered land planted with grasses and other durable plants such as clover which are maintained at a short height with a lawn mower and used for aesthetic and recreational purposes. To get a good lawn, one should take precautions right from the beginning. It requires good grass and proper technique to make such a lawn and constant attention to maintain it in high standard. Weeds are a major problem which creates a hindrance in making a beautiful lustrous lawn. Weeds occur in every lawn, but they seldom become problems in well-managed, vigorously growing turf grass. Proper site preparation and turf grass selection before planting are essential to give a new lawn a healthy start. Once a lawn is established, poor maintenance practice that weakens it include improper irrigation, fertilization, or mowing are likely to predispose it to weed invasion. Activities that lead to compaction also contribute significantly to turf grass stress, making it easier for weeds to invade.

Turf can become infested with annual and perennial grasses (not the planted cultivar) and broadleaf plants that are controlled by the use of various herbicides. Herbicides provide a convenient, economical and effective way to manage weeds. They allow fields to be planted with less tillage, allow earlier planting dates and provide additional time to perform the other tasks that the farm requires. Due to reduced tillage, soil erosion has been reduced from about 3.5 billion tons in 1938 to one billion tons in 1997, thus reducing soil from entering waterways and decreasing the quality of the Nation's surface water (Siddappa *et al.*, 2016).

There are different kinds of pre-emergence and post emergence herbicides that are being applied for the control of weeds in a lawn. The availability of different mechanisms of action is an essential factor for crop management to reduce selection pressure and to create alternatives of control. Pre emergence herbicides are effective control agents for several weeks to months on most annual grass weeds. These have proven highly effective by providing excellent weed control with little or no injury to turf.

Materials and Methods

The experiment was conducted in the Experimental Farm of Department of Horticulture, Assam Agricultural University, Jorhat-785013, during the year 2017-18. The experimental soil was well drained, sandy loam in texture, having pH 5.5. Korean doob grass (*Cynodon dactylon* L. Pers) was used during the experiment. The treatments consisted of T_1 (Control), T_2 (Hand weeding at 15 days interval up to 90 days), T_3 (Hand weeding at 30 days interval up to 90 days), T_4 (Pendimethalin @ 1 kg a.i./ha), T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45days, 60 days, 75 days after planting), T_6 (Sulfosulfuron @ 25 g/ha) and T_7 (Sulfosulfuron @ 25 g/ha followed by hand weeding at 45 days, 60 days, 75 days after planting). Pendimethalin was applied as pre-emergence herbicide to the specified plots 2 days after dibbling with Knapsack manual sprayer having flat fan nozzle. Likewise, Sulfosulfuron was applied as post-emergence herbicide 25 days after planting to the specified plots. The experiment was laid out in Randomized Block Design (RBD) with 3 replications. Total number of plots was 21, each having a size of 6 square metres.

Weed flora analysis

After planting of the doob grass in the experimental field, the emergence pattern of various weed species under different treatments were studied. Data on weed flora present in the experimental field were recorded during the experimental period at 15 days interval up to 150 days after planting (DAP). The weeds that were easy to identify were recorded in the field. Those species which could not be identified in the field were brought to the laboratory and were identified using the weed identification guide (Stroud and Parker, 1989).

Weed density (numbers/m^2)

The weed count was calculated at periodic intervals of 30 days up to 150 days after planting by taking the number of weeds per m^2. The weed density was recorded by throwing quadrate randomly at three places in each plot. The weed species found within the sample quadrate were identified, counted and expressed in numbers/m^2.

Weed dry weight (g/m^2)

The weeds falling within the quadrate were cut near the soil surface immediately after taking observation on weed count and placed into paper bags treatment wise. The samples were sun dried for 3-4 days and thereafter were placed in an oven at 65°C temperature till constant weight. Subsequently their dry weight was measured and was expressed in g/m^2.

Weed control index (W.C.I.)

The comparisons of W.C.I. based on the weed density of various treatments were evaluated from the collected data by using the following formula:

$$\text{W.C.I.} = \frac{\text{Weed density in no./m}^2\text{ in control plot} - \text{Weed density in no./m}^2\text{ in treated plot}}{\text{Weed density in no./m}^2\text{ in control plot}} \times 100$$

Weed control efficiency (W.C.E.)

The efficiency of the methods of weed management based on the dry matter production by weeds was evaluated from the data with the help of the following formula:

$$\text{W.C.E.} = \frac{\text{Weed dry matter in g/m}^2\text{ in control plot} - \text{weed dry matter in g/m}^2\text{ in treated plot}}{\text{Weed dry matter in g/m}^2\text{ in control plot}} \times 100$$

Selection of grass

Three patches of grass from each plot were selected randomly for recording the observations. The selected plants were tagged 1-3 in each plot for facilitating correct measurements. All the observations on growth parameters were recorded at 30 days interval.

Results and Discussion

Weed density

Weed Density of different treatments was taken at 15 days interval upto 150 days after planting (DAP) and it was found that significantly lower weed density was recorded in treatment T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 days after planting) (Table 1 and Fig. 1). The weed density and weed biomass in the experiment were highest in control (T_1), because the weeds were allowed to grow without following management practice. The results are in line with the research works of Bangi *et al.*, (2014), Ali *et al.*, (2011) and Sharma and Chander (1996). The heavy rainfall during the mid part of the growing season may also be the reason for the increased weed density throughout the period of observation. The weed density in the treatment T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45, 60, 75 days after planting) were found to be lowest. Similar results commensurate with the findings of Chandolia *et al.,* (2010) and Bangi *et al.,* (2014). It is due to the damage caused to germinating weed seeds by the pre-emergence application of pendimethalin in the early stage followed by hand weeding at 45, 60 and 75 days after planting. Singh (2011) also reported similar type of observations. The hand weeding method of weed control at 15 days interval up to 75 days after planting (T_2) was found to be effective next to T_5. Similar results commensurate with the findings of Oluwafemi (2013). T_5 was found to be most effective in minimizing the weeds in a lawn. As pendimethalin was applied in the early part of the growing season, so the weed density was low from the beginning.

Weed dry weight

The weed dry weights of different treatments were taken at 15, 30, 45, 60, 75, 90, 105, 120, 135 and 150 days after planting (DAP) and a significant effect of the treatments were found (Table 2 and Fig. 2). The dry weight of weeds proportionally increased with the increasing number of weeds. The weed biomass in the experiment was highest in control (T_1), because the weeds were allowed to grow without following management practice. The results are in line with the research works of Bangi *et al.,* (2014), Ali *et al.,* (2011) and Sharma and Chander (1996). The weed dry weights in the treatment T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45, 60, 75 days after planting) were found to be lowest. Similar results commensurate with the findings of Chandolia *et al.,* (2010) and Bangi *et al.,* (2014). It is due to the damage caused to germinating weed seeds by the pre-emergence application of pendimethalin in the early stage followed by hand weeding at 45, 60 and 75 days after planting. As hand weeding was also taken up towards the later part, hence it resulted in low dry matter accumulation in the weeds.

Weed control index

The Weed Control Index of different treatments at different stages of observation is presented in Table 3. It is evident that the highest WCI was achieved by treatment T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 days after planting) at all the stages of observation. The weed control index was highest in treatment T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45, 60 and 75 days after planting) throughout the period of investigation, which was followed by treatment T_2 (hand weeding at 15 days interval up to 90 DAP). This may be due to the preventive effect of pendimethalin which prevents the early emergence and establishment of weeds, and additionally the integration of hand weeding at 45, 60 and 75 DAP helped to reduce the density of weeds better than rest of the treatments. Similar results commensurate with the findings of Nagamani *et al.,* (2011).

Weed control efficiency

The Weed control efficiency of different treatments at different stages of observation is presented in Table 4. The weed control efficiency of the plots applied with T_5 was highest, which was followed by T_2. As the weed dry weight was lowest in T_5, so this treatment resulted in highest weed control efficiency. The better performance of low dose of this herbicides supplemented with hand weeding may be due to the initial control of weeds with herbicides and next flush of weeds were reduced by hand weeding, even though rain occurred towards the mid part of the growing season. The hand weeding helped to control the late emerging weeds. Similar types of observations were observed by Nagamani *et al.,* (2011).

Growth parameters of Korean doob grass

Shoot length (cm)

The shoot length of Korean doob at different stages of observation is presented in Table 5. The shoot length of doob grass was significantly influenced by weed management practices. T_5 (Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45, 60 and 75 DAP) recorded the highest shoot length throughout the period of investigation. The reason behind better shoot length in T_5 may be due to the suppression of weeds by the herbicide in the early stages and at later stage due to the hand weeding. Thus, under least crop-weed competition, adequate availability of light, optimum temperature, adequate space along with improvement in physiological and morphological characters of the plant can be responsible for greater photosynthetic rate for more accumulation of plant dry matter (Duncan, 1971) and increased shoot length. Thus, congenial nutritional environment might have increased metabolic processes in plants resulting in greater meristematic activity and apical growth thereby improving shoot formation and retention of higher number of leaves/plant which resulted in enhanced dry matter production and higher shoot length. More sunlight penetration to the crop plants might have also made photosynthates more available that triggered growth resulting in increased plant height. On the other hand, as a consequence of the suppressing effect of weeds on the crop, the minimum shoot length was recorded in weedy check (T_1). Similar findings were reported by Chattha *et al.,* (2007).

Number of leaf blades/plant

The number of leaf blades/plant of Korean doob at different stages of observation is presented in Table 6. The number of leaf blades per plant was significantly influenced by application of different treatments at difference stages after planting. It was observed that application of Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 days after planting (T_5) recorded more number of leaf blades per plant than other treatments. The reason may be the less weed competition in respect of application of herbicide in the early stage of lawn development, followed by hand weeding in the later stages of growth. Under reduced density and dry matter of weeds, plant gets sufficient space for optimum expansion of leaf blades as early as possible. Chandolia *et al.,* (2010) reported similar trend of findings. This had led to better growth of the doob grass. However, T_1 recorded the least number of leaf blades. The reasons may be due to the higher emergence of the weed species, which increased the competition of the doob grass to grow efficiently. Similar findings were observed by Edossa (2015).

Number of stolons per plant

The number of stolons/plant of Korean doob at different stages of observation is presented in Table 7. The number of stolons per plant was significantly influenced by application of different treatments at difference stages after planting. It was observed that application of Pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 days after planting (T_5) recorded more number of stolons per plant than other treatments. The number of stolons per plant were highest in T_5 due to less weed competition in respect of application of herbicide in the early stage of lawn development, followed by hand weeding in the later stages of growth. The maximum stolon number under T_5 was attributed to increased endogenous cytokinin levels. Cytokinins have been shown to increase carbohydrate partitioning to the crown (Ervin and Zhang, 2003). Increased carbohydrate levels provide energy for auxillary bud growth, resulting in an increase in stolon number.

Grass spread (cm) per plant

Grass spread per plant was recorded at monthly interval is presented in Table 8. It was revealed from the observation that the grass spread per plant was found to be more in the treatments having combination of herbicide application along with manual weeding. Application of pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days and 75 DAP (T_5) was found to have more grass spread per plant (cm), which was followed by application of sulfosulfuron @ 25 g/ha followed by hand weeding at 45 days, 60 days and 75 days after planting. However, T_1 (Control) recorded the least grass spread per plant throughout the period of observation. This might be due to the consequence of competition offered by weeds for growth resources such as space, light and the nutrients, but it failed to bring it to a significant level. Similar justifications were reported by Zimdahl (2007).

Table.1 Weed density (numbers/m^2) after various days of planting as affected by treatments

Treatments	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	105 DAP	120 DAP	135 DAP	150 DAP
T_1	59.00	76.33	103.67	128.33	164.67	187.67	216.00	244.67	282.67	325.33
T_2	55.67	51.00	56.00	57.00	49.00	48.67	58.00	84.33	114.33	125.33
T_3	58.33	66.33	55.67	72.67	56.67	77.67	71.67	111.00	128.67	153.00
T_4	38.67	51.67	55.00	73.67	85.00	102.00	118.00	139.00	163.33	180.00
T_5	37.67	50.33	51.67	49.67	44.67	46.67	54.33	65.33	89.67	98.67
T_6	54.67	61.33	68.67	75.67	86.67	104.67	128.00	148.33	167.67	182.33
T_7	52.00	60.67	68.00	60.00	58.33	59.67	82.33	105.33	135.33	153.67
S.Ed(±)	1.88	4.66	4.29	4.12	4.11	4.64	6.16	6.45	7.94	7.44
CD (P=0.05)	4.10	10.16	9.35	8.97	8.95	10.11	13.42	14.05	17.30	25.34

DAP= Days after Planting

Table.2 Weed dry weight (g/m^2) as affected by treatments

Treatments	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	105 DAP	120 DAP	135 DAP	150 DAP
T_1	8.63	21.00	83.71	172.94	220.9	244.6	279.47	306.16	348.90	351.61
T_2	8.19	13.93	18.96	39.01	50.07	54.23	70.29	99.56	115.45	134.00
T_3	8.41	18.85	18.58	56.51	64.4	79.46	81.75	114.29	125.79	156.98
T_4	5.45	14.37	18.33	57.81	93.66	132.92	155.83	172.88	187.48	203.00
T_5	5.34	13.42	15.05	36.56	44.61	50.65	66.13	78.70	92.93	109.53
T_6	7.99	15.74	39.83	59.32	95.65	137.59	158.81	179.26	190.23	206.52
T_7	7.61	15.98	38.22	45.29	66.53	68.48	89.16	116.78	127.26	161.12
S.Ed(±)	0.38	1.00	2.18	3.10	5.64	4.36	5.37	6.25	7.33	6.73
CD (P=0.05)	0.83	2.19	4.75	6.75	12.28	9.51	11.70	13.61	15.98	14.67

DAP= Days after Planting

Table.3 Weed control index (%) of the different treatments

Treatments	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	105 DAP	120 DAP	135 DAP	150 DAP
T_1	-	-	-	-	-	-	-	-	-	-
T_2	5.65 (2.47)*	33.18 (5.80)	45.98 (6.82)	55.58 (7.49)	70.24 (8.41)	74.07 (8.63)	73.15 (8.58)	65.53 (8.12)	59.55 (7.75)	61.48 (7.87)
T_3	1.13 (1.26)	13.10 (3.69)	46.30 (6.84)	43.38 (6.62)	65.59 (8.13)	58.62 (7.68)	66.82 (8.20)	54.63 (7.42)	54.48 (7.41)	52.97 (7.31)
T_4	34.46 (5.91)	32.31 (5.73)	46.95 (6.89)	42.60 (6.56)	48.38 (6.99)	45.65 (6.79)	45.37 (6.78)	43.19 (6.60)	42.22 (6.53)	44.67 (6.72)
T_5	36.16 (6.05)	34.06 (5.88)	50.16 (7.12)	61.30 (7.86)	72.88 (8.56)	75.13 (8.70)	74.85 (8.69)	73.30 (8.59)	68.28 (8.29)	69.67 (8.38)
T_6	7.34 (2.79)	19.65 (4.48)	33.76 (5.85)	41.04 (6.44)	47.37 (6.92)	44.23 (6.68)	40.74 (6.42)	39.37 (6.30)	40.68 (6.41)	43.95 (6.66)
T_7	11.86 (3.51)	20.52 (4.57)	34.41 (5.91)	53.25 (7.33)	64.58 (8.07)	68.21 (8.29)	61.88 (7.90)	56.95 (7.58)	52.12 (7.25)	52.77 (7.30)
S.Ed(±)	0.15	0.11	0.09	0.06	0.08	0.12	0.17	0.11	0.08	0.09
CD (P=0.05)	0.33	0.25	0.19	0.13	0.17	0.27	0.37	0.24	0.17	0.19

*Square root transformed value in the parenthesis
DAP= Days after Planting

Table.4 Weed Control Efficiency (%) of the different treatments

Treatments	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	105 DAP	120 DAP	135 DAP	150 DAP
T_1	-	-	-	-	-	-	-	-	-	-
T_2	5.10 (2.36) *	33.67 (5.84)	77.35 (8.82)	77.44 (8.83)	77.33 (8.82)	77.83 (8.85)	74.85 (8.68)	67.48 (8.24)	66.91 (8.21)	61.89 (7.90)
T_3	2.55 (1.71)	10.24 (3.26)	77.80 (8.85)	67.32 (8.23)	70.85 (8.44)	67.51 (8.24)	70. 75 (8.44)	62.67 (7.95)	63.95 (8.03)	55.35 (7.47)
T_4	36.85 (6.11)	31.57 (5.66)	78.10 (8.86)	66.57 (8.19)	57.60 (7.62)	45.66 (6.79)	44.24 (6.68)	43.53 (6.63)	46.27 (6.83)	42.27 (6.54)
T_5	38.12 (6.21)	36.10 (6.05)	82.02 (9.08)	78.86 (8.91)	79.81 (8.96)	79.29 (8.93)	76.34 (8.76)	74.29 (8.65)	73.36 (8.59)	68.85 (8.33)
T_6	7.42 (2.79)	25.05 (5.05)	52.42 (7.28)	65.70 (8.13)	56.70 (7.56)	43.75 (6.65)	43.17 (6.60)	41.45 (6.47)	45.48 (6.80)	41.26 (6.46)
T_7	11.82 (3.50)	23.90 (4.93)	54.34 (7.40)	73.81 (8.62)	69.88 (8.39)	72.00 (8.51)	68.10 (8.28)	61.86 (7.89)	63.53 (8.00)	54.18 (7.39)
SE.d(±)	0.13	0.11	0.10	0.16	0.19	0.20	0.08	0.09	0.08	0.09
CD (P=0.05)	0.28	0.25	0.22	0.34	0.42	0.45	0.18	0.20	0.17	0.20

*Square root transformed value in the parenthesis
DAP= Days after Planting

Table.5 Effect of weed control methods on shoot length (cm) of Korean doob

Treatments	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	4.82	5.91	6.32	6.89	7.73
T_2	5.01	7.08	7.59	9.01	10.63
T_3	5.04	6.87	7.50	8.64	10.43
T_4	5.66	6.78	7.48	8.23	9.42
T_5	5.80	8.17	8.52	10.14	12.56
T_6	5.23	6.66	7.26	7.19	9.45
T_7	5.32	7.49	8.11	9.97	11.25
S.Ed (±)	0.18	0.43	0.37	0.46	0.54
CD (P=0.05)	0.57	0.93	0.80	1.00	1.18

DAP= Days after Planting

Table.6 Effect of weed control methods on number of leaf blades per plant (Numbers/plant) of Korean doob grass

Treatments	Number of leaf blades/plant				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	20.81	35.11	42.89	52.78	66.78
T_2	25.66	52.48	64.44	78.14	110.46
T_3	22.96	51.48	60.00	76.37	109.19
T_4	27.11	41.90	56.72	74.77	104.49
T_5	28.30	57.60	75.04	88.96	120.10
T_6	24.50	40.08	53.34	72.75	101.13
T_7	25.63	54.79	73.96	83.35	115.50
S.Ed (±)	1.46	2.01	2.55	3.09	4.31
CD (P=0.05)	3.19	4.37	5.56	6.73	9.40

DAP= Days after Planting

Table.7 Effect of weed control methods on number of stolons per plant of Korean doob

Treatments	Number of stolons/plant				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	3.74	5.93	7.59	10.76	11.97
T_2	5.81	7.66	10.31	12.93	14.60
T_3	3.77	7.51	8.96	12.40	13.92
T_4	6.08	6.55	8.30	11.98	12.74
T_5	6.65	8.98	11.93	14.62	16.26
T_6	6.02	5.75	8.08	11.41	12.66
T_7	6.34	8.78	11.04	13.26	15.75
S.Ed (±)	0.50	0.54	0.56	0.76	0.64
CD (P=0.05)	1.09	1.19	1.23	1.66	1.39

DAP= Days after Planting

Table.8 Grass spread (cm) per plant at monthly interval

Treatments	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	3.60	4.96	9.68	10.86	14.37
T_2	5.52	8.02	12.04	14.08	16.45
T_3	4.71	7.48	11.79	13.56	16.08
T_4	6.74	7.42	11.72	13.26	15.57
T_5	6.80	9.48	13.45	15.38	18.12
T_6	5.86	6.85	11.00	12.94	14.92
T_7	5.93	8.89	12.93	14.96	17.19
SE.d (±)	0.34	0.32	0.51	0.49	0.67
CD (P=0.05)	0.74	0.71	1.12	1.08	1.46

DAP= Days after Planting

Fig.1 Weed density as affected by different treatments

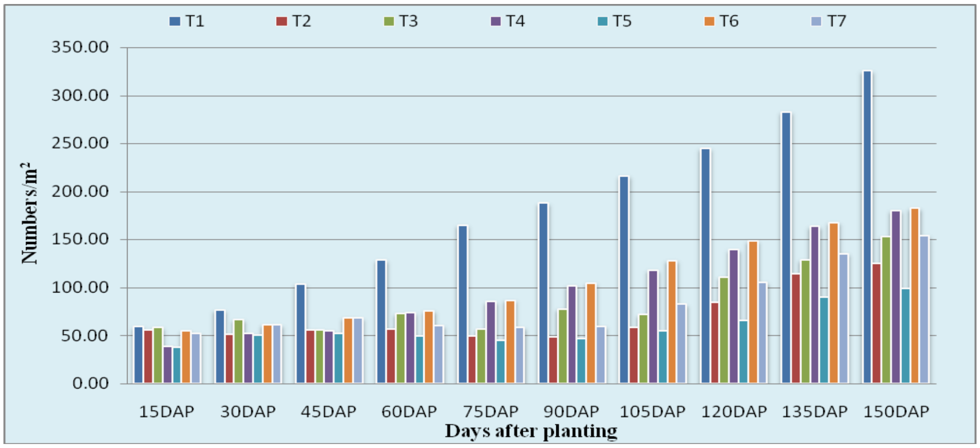
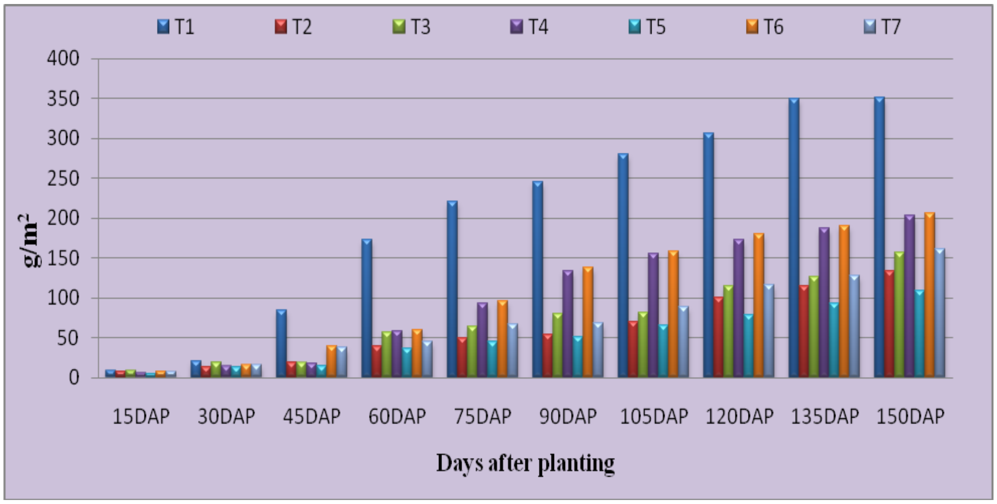


Fig. 2 Weed dry weight as affected by different treatments



From the experiment, it could be concluded that incorporation of hand weeding along with herbicide is recommended for better control of weeds in a lawn. Moreover, application of pendimethalin @ 1 kg a.i./ha followed by hand weeding at 45 days, 60 days, 75 DAP was found effective in minimizing weeds in a lawn. Due to the application of the treatment T_5, better growth of lawn grass was observed.

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